DOCUMENT RESUME

ED 045 078 JC 710 006

AUTHOR	Brightman, Richard W.
TITLE	The Computer and the Junior College: Curriculum.
INSTITUTION	American Association of Junior Colleges, Washington, D.C.
PUB DATE	70
NOTE	42p.
AVAILABLE FROM	American Association of Junior Colleges, One Dupont Circle, N.W., Washington, D.C. 20036 ($1.50)
EDRS PRICE	EDRS Price MF-$0.25 HC-$2.20
DESCRIPTORS	*Computer Programs, *Curriculum, *Curriculum Development, *Data Processing, Data Processing Occupations, Educational Technology, *Junior Colleges, Programing

ABSTRACT

Rather than suggest specific course outlines, this report provides guidance for continued development of computer curricula, discusses established principles, and helps to revise current programs. Junior colleges should offer specialized programs for students planning to work as professional data processors. They should also provide computer literacy courses for students and offer education in computer programing skills for non-data processing majors. Considerations for implementing and operating data processing educational programs are: (1) general organization; (2) staffing; (3) communication between the high schools and junior colleges; and (4) evaluation. There are nine steps in the actual development of such programs: (1) establish objectives; (2) survey the community; (3) form an advisory committee; (4) determine the organizational structure; (5) hire or appoint staff; (6) design the curriculum; (7) determine equipment needs and sources; (8) make the equipment available; and (9) begin. (CA)

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The Computer and the Junior College: Curriculum

Richard W. Brightman

UNIVERSITY OF CALIF.
LOS ANGELES

JAN 18 1971

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One Dupont Circle, N.W.
Washington, D.C. 20036

Printed in U.S.A.

Price: $1.50

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Preface

This publication was developed by the Occupational Education Project of the American Association of Junior Colleges with the assistance of the W. K. Kellogg Foundation. The project expresses the Association's deep interest in providing guidance to junior colleges in the development of occupational education curricula.

During the past decade, junior colleges have made significant contributions to the urgent manpower demands for highly-skilled technical personnel in the computer field. Many of the graduates of our junior college programs are now in key leadership positions in the computer installations of business, industry, and government. During this same period, the technology of the use of the computer has undergone a continuous series of major changes. The degree of change and the speed with which it has occurred has placed unprecedented pressures on junior colleges to keep pace.

A previous publication of the Association, The Computer and the Junior College, *sought to provide a campus-wide perspective for the computer. It is in that context that this discussion about the curriculum is placed. It is the purpose of this publication to provide guidance and rationale for the continuing development of computer curriculum, and to relate principles distilled from the milieu by the cumulative years of successful experience of this national advisory committee.*

Gilbert D. Saunders
Specialist in Occupational Education

National Advisory Committee for Computer Curriculum

Richard W. Brightman
Assistant Director
Educational Development
Orange Coast Junior College District
2701 Fairview Road
Costa Mesa, California 92626

James M. Adams
Director of Automated Education
The American Bankers Association
90 Park Avenue
New York, New York 10016

Andrew A. Burgoyne
IBM Corporation
Industry Marketing-Education
1825 K Street, N.W.
Washington, D.C. 20036

Dr. J. Daniel Couger
Assistant Dean
University of Colorado
Colorado Springs Center
Cragmor Road
Colorado Springs, Colorado 80907

James R. Hill
Coordinator of Data Processing
Dallas County Junior College
Main and Lamar Streets
Dallas, Texas 75202

Robert A. Kelley
Chairman, Division of Business Administration
Corning Community College
Corning, New York 14830

Ted Tilton
Chairman, Data Processing Department
College of Dupage
Glen Ellyn, Illinois 60540

Dr. Lewis E. Wall
Assistant Professor
Department of Business Teacher Education
School of Business
Western Illinois University
Macomb, Illinois 61455

AAJC STAFF: Gilbert D. Saunders

Specialist in Occupational Education
American Association of Junior Colleges
One Dupont Circle, N.W. Suite 410
Washington, D.C. 20036

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Introduction

Recent technological advances justify courses designed to acquaint all students with the importance and pervasiveness of automated data processing.

The Promise and The Problem

Chances are that computers are here to stay. With over 40,000 computers in use in the United States today, and thousands more on order from manufacturers hard-pressed to meet demands from eager customers, it seems safe to conclude that computers have become a permanent aspect of American life. Each week for the last several months, for example, every major newspaper in the United States has published at least one news article or editorial about computers—what they do, what they do wrong, how they do it and how fast, and, more and more often, how crucial they have become in the day-to-day commercial and social affairs of men.

Although initially thought of as calculating devices, or, in their earlier days, as "thinking machines," computers are most widely used in the world of commerce. Businessmen now embrace computers as the essential element in their efforts to handle data processing chores virtually impossible to accomplish using any manual or non-automated method. Producing statements of account for several hundred thousand telephone subscribers, for instance, simply cannot be done these days without the use of computers.

The computer has introduced a new set of workways into business and education. These often increase the pace of intellectual aggressiveness, causing educators and businessmen to think not only of new questions to ask but also new ways in which to ask old questions. These questions are becoming increasingly more comprehensive and complex; they are coming faster, and answers are being demanded sooner.

Manufacturers of computing equipment seem just able to keep production of their machines close behind demand for them. But this is not the case with regard to the availability of men and women who make the machines work. Professional and trade magazines all bemoan the lack of trained personnel in data processing.

Enter the Junior College

When the so-called "second generation" of computer systems was introduced, a few junior colleges began exploring the roles that two-year schools would play in meeting the need for trained data processing personnel. This initial exploration resulted, in 1962, in a U.S. Office of Education publication containing curriculum guidelines and course outlines for data processing in the junior college. The twc-year program was designed to prepare junior college graduates for entry-level jobs in the data processing industry.

Recent developments in computer system design and in techniques by which computers are used and programmed, suggests a need for new criteria to evaluate data processing instruction and, consequently, new methods for the design of data processing curricula. Publications on the subject become dated for two major reasons. First, computer technology itself changes rapidly. Second, industry experience in using computing machinery and the experience of educators in teaching students how to use it continually uncover new aspects of both technique and pedagogy.

As a result, educators face demanding responsibilities of designing, maintaining, and evaluating curricular efforts. Not only must current employment needs of students be considered, but preparation for the next several years must be implicit in the design of all instructional programs. This is difficult enough for non-data processing vocational programs. The changing nature of data processing as a field of endeavor compounds the problem. Data processing is today one of the few areas in occupational training in which each faculty member is called upon to learn more new things than are his students.

The difficulties, of course, do not justify doing the educational job poorly. If a college cannot do the job well, for reasons of economics, personnel, or whatever, then that college should not try to do it.

Providing students with an up-to-date, career-oriented curriculum is essential if the junior college is to properly discharge its responsibility. The graduates' growth potential, however, must not be stifled by educational experiences geared only to meeting the needs of employers today, many of whose operations do not yet reflect the advanced state of data processing technology. Learning experiences should not be geared to meeting the current level of technical competence of available faculty. Of course, immediate local needs and faculty strengths should not be ignored. The college must accept the responsibility for providing learning experiences that are timely, that provide for the professional growth of graduates, and draw on particular strengths and abilities of the teaching staff.

About This Book

This publication considers computers and data processing as a subject as well as a tool of instruction. It will not attempt to provide specific course outlines, but rather it will concentrate on developing guidelines to be used by those responsible for curriculum design. It will also be useful to those who are faced with the necessity, as almost all are, of revising their current programs. New perspectives may be garnered by faculty and administrators from a description of the computer's multiple roles within the college. Computer studies will, of necessity, be linked with school organization, teaching personnel, equipment, interinstitutional articulation, and program evaluation.

Educational institutions often fail to make computer knowledge a part of every student's curriculum. This publication includes arguments for general education in computers and data processing, and suggestions on how it can be handled.

Chapter II of this booklet concerns programs that prepare students in non-data processing fields who are likely, by virtue of their profession, to require some skills in data processing, particularly computer programming. Considerations of curricula that should be offered in community colleges for data processing occupations appear in Chapter III. Parts IV through VIII treat important considerations for implementing and operating data processing educational programs.

I. General Education

One of the purposes of providing computer literacy is to remove its aura of "magic."

This section examines data processing as a field of general study for all students, particularly those who have not chosen it as their profession. Recent technological advances justify the inclusion in all college curricula of coursework designed to acquaint students with the importance and pervasiveness of automated data processing in American life, especially the digital computer.

In the November 1967 issue of *American Education,* R. Louis Bright, associate commissioner for research, U.S. Office of Education, asked: "What does this [technological advancement] mean for educators? It means that unless high schools and colleges start telling their students how their lives and work will be changed by computers, they are selling them short."

Toward Computer Literacy

The chief objective of general education courses is to provide students with a knowledge and understanding of computers equivalent to that obtained in art, literature, and music surveys. Coursework designed to develop computer literacy—a term describing the general understanding of computers and what they do—is highly recommended. Such courses may be introductory to the professional curriculum, but we should recognize that the goals of an introductory course may be different from the goals of computer literacy courses. Computer literacy should be required of all college students and of all high school students too, whatever their field of work might be.

Certain areas of computer literacy are pertinent to all educated persons:

1. A knowledge and appreciation of the development of automated data processing techniques and particularly the stored program digital computer
2. Basic concepts of automated data processing including data storage and access devices and techniques of using them; equipment function, operation, and control methods; the stored program concept; and basic ideas behind data processing systems design
3. The uses to which automated data processing devices are put
4. The social impact of technological advances in computer technology.

In addition to these broad topics, students in certain disciplines need additional coverage of specific data processing techniques and applications relevant to their field of study. Students in mathematics, engineering, and the sciences, for example, should come away from their freshman and sophomore years with working skills in a procedural programming language such as FORTRAN.

The Curriculum for Computer Literacy

Computer literacy can be developed in more than one way. The subject matter may be integrated into course offerings in social science and humanities in such a manner that the objectives become a fundamental part of those courses; or a survey course in data processing may be offered for general enrollment.

The second of these two alternatives is by far the best; and it is also the easiest to implement. This is because most non-data processing teachers today lack sufficient knowledge. Indeed, our experience shows that many faculty members view computers with anxiety and trepidation, if not with outright antagonism. Expecting computer literacy to be imparted from computer-illiterate faculty is unrealistic.

There remains, then, the alternative of offering a general course which introduces the field to all students. Such a course, familiar in many two- and four-year colleges, is supported by a number of good textbooks, and is particularly popular in evening courses for adults.

If the junior college offers a program for data processing majors, it must answer the question of whether or not the general survey or introduction course should serve both data processing majors and students who do not intend to major in the field. It is sometimes argued that if it serves both parties, it probably will not adequately prepare data processing majors for advanced work. On the other hand, if two introductory courses are offered, one for majors and one for non-majors, those students who enroll in the non-major offering and later decide to major in data processing will have to take the introductory course again to get the technical background they missed.

One of the most important general functions of junior colleges is to provide opportunities for students to find themselves. Colleges should not penalize those students who change their minds during the finding process.

Staff Requirements

If the college offers a major program in data processing, instructors for the general course can be chosen from among the faculty. Care should be taken, however, that teachers of the computer literacy course be generalists enough to point out to students the relative importance of computers in relation to other areas of life. A highly specialized instructor may well overstate the technical values of computer systems while underplaying their concomitant human and social values and conflicts.

If the college has no major program, teaching faculty may be drawn from members who have the inclination and the ability to do the job. The college may operate a data processing installation of its own for administrative purposes. Operating personnel of this installation may be able to serve as part-time teachers of the course, though it is well to be cautious when employing those who may have become over-specialized.

A Computer for Computer Literacy?

An on-site computer is not required for computer literacy education, but the availability and use of one can enhance students' understanding. The general course provides students with an understanding of how a computer is used in their profession and in everyday life. It is not intended to provide job skills necessary for computer operators and programmers.

However, one of the underlying purposes of providing computer literacy is to remove its aura of "magic." One of the most effective ways to do this is to have students write simple computer programs which are executed, and the results returned to them. When students are allowed to execute their programs themselves, they feel the excitement of having mastered the "electronic brain." If it is possible to provide this experience, the general education course will be far better. But this is not to say that the college should acquire a computer solely for that purpose.

If the college has no computer installation of its own, or even if it has one, field trips to local commercial and scientific installations, if properly planned, can be of great value. Students like to see computers operate, and they should not be denied the opportunity if arrangements can be made with a local business or government installation.

Without planning, a field trip can be a disappointing experience. Care should be taken to brief students on the data processing application they will observe. The tour should include an explanation, by company personnel, of the processing steps they will see. The class should view actual input documents, the keypunching operations and card production, the steps involved in transferring cards to tape or disk, and the controls imposed for balancing and accuracy. The responsibilities of the computer operators in running the job; examples of computer output for the application; controls on output; and the final disposition of reports or documents produced should all be thoroughly reviewed.

II. Education for Students in Non-Data Processing Professions

The computer can convert routine courses into exciting experimental subjects.

This section examines data processing as a subject of study for students majoring in other occupational or pre-professional areas. Two broad areas—business and scientific-technical fields—are examined.

Business Fields

Every student pursuing a business-related program of study should have some exposure to the computer and the resultant social and economic impact of its widespread utilization. Coursework will, naturally, be influenced by the degree to which data processing has already been applied in firms in the employer community. The curriculum should reflect employers' plans for introducing data processing in the future, as well as graduates' occupational and geographic mobility.

Objectives

A business curriculum should include, in addition to a computer literacy course, the following topics:

Present and probable applications
Fundamentals of a programming language
Employment considerations

The above list is hardly exhaustive. It is quite possible that a single introductory course, cross-referenced to other areas of study, may serve the needs of all non-data processing students. The topics identified above could be left open-ended to permit the inclusion of materials most appropriate to the students' areas of study (retailing, transportation, secretarial, accounting, and others). This approach allows administrators to make more efficient use of existing personnel, instructional materials, and classroom facilities. The open-ended section, if not the entire course, could be presented by specialists in the students' major fields—assuming they are familiar with related computer applications in business and industry.

Curriculum Considerations

The major direction for all data processing courses should come from specialists and computer curriculum planners. This should not preclude, however, the involvement of accountants, social scientists, engineers, and others. To the extent that they are qualified, non-data processing faculty should participate in computer education in their respective areas. Not only will this involvement better assure a reserve of personnel to handle related courses, it will facilitate integration of subject matter.

Some career programs in business should include more than an introductory course. The two-year accounting curriculum ought to specify a problem or procedure-oriented computer programming language. Additionally, students majoring in purchasing, distribution, industrial/production

technology, general business, and office machines operations/office administration need to know a great deal more about computers and computer applications than would be covered in an introductory course. Some additional topics for coverage in the respective areas include:

Accounting — Flowcharting techniques; automated and manual systems and procedures; inventory, payroll, accounts receivable/payable, and cost accounting applications; and COBOL programming techniques. (Students should be able to write and check out problems found in most introductory texts.)

Technology — Inventory, production scheduling, and cost accounting applications; a knowledge of a computer programming language that takes into consideration the students' quantitative skills; and systems and procedures.

Business — The nature of the position for which these majors should qualify necessitates their familiarization with fundamentals of computer operations in most areas associated with office work. Additional training for these students should follow somewhat the same pattern as that of the accounting major except that breadth rather than depth coverage will be emphasized.

Office Operations — Limited hands-on exposure to the computer and peripheral equipment (on-line and off-line) may be useful for students majoring in this program. Their training could also include the principles and practices involved in preparing, transporting, storing, and protecting data files. The degree to which students are given a more in-depth coverage of data processing will depend on the extent to which local industry has automated its office procedures.

Distribution — Inventory, distribution cost, and logistical-analytical techniques that are possible through computer processing should form the core of advanced training in data processing. It is not necessary to include a programming language in the distribution major's program of study, but he should be fully familiar with the services that the data processing center can provide.

Table I illustrates some data processing topics, and business areas in which these topics might logically be taught.

	Accounting	Production	General Business	Office	Distribution
PROGRAMMING SKILLS					
Flowcharting	X	X	X	X	X
COBOL	X				X
FORTRAN		X			X
PL/1	X	X			X
RPG	X		X		X
Decision Tables		X			X
AUTOMATED APPLICATIONS					
Inventory	X	X	X		X
Production Scheduling	X	X			X
Accounts Receivable	X		X		X
Accounts Payable	X		X		X
Sales Analysis	X		X		X
OPERATING SKILLS					
Computer Room Operations				X	
Data File Handling		X	X	X	
Source Document Preparation	X	X	X	X	X

It is not imperative that separate courses be maintained to provide advanced education for the non-data processing business programs described above. It would seem more feasible to provide one or two second-level core courses to all students needing common exposure to advanced

topics. Although these students may not become computer specialists, they will have a better-than-average knowledge of computers and their use.

If the college does not find it feasible or economical to offer courses tailor-made to students' programs, it should at least make it possible for non-majors in business to take advanced courses offered to data processing majors. For those students whose career fields have been greatly influenced by modern computer applications, a more technical orientation to subject matter is preferable to none but introductory coursework.

Scientific-Technical Fields

Objectives

The computer is a tool that can fit into existing curricula and help convert routine courses into exciting experimental subjects. The use of computers in this mode would encompass the following objectives:

1. Develop student appreciation of the computer's role in society both now and in the foreseeable future.
2. Motivate students and teachers to more individual, challenging instruction.
3. Enrich existing programs through use of the computer.
4. Develop an early recognition of, and a deeper insight into, concepts of mathematics, logic, and science.
5. Encourage faculty and students to apply computer concepts creatively to other areas of the instructional program.

Curriculum Considerations

Perhaps the most exciting application of computer technology in the curriculum of today's schools is in the area of problem solving—the use of a computer to assist in the study of problems of an existing, non-computer curriculum. In this sense, problem solving is said to be curriculum-oriented, not computer-oriented.

The incorporation of problem solving into an existing curriculum can provide meaningful, challenging exercises, and the type of problems that allow computation to be eliminated and concept to be stressed. An example of such a problem would be the computation of an irrational root of a higher degree equation, where the concept is relatively easy to teach but the computation is tedious. Another example, this time drawn from elementary physics, involves the calculation of the range and height of a projectile being fired from a cannon. Using a computer in a manner similar to that of a slide rule allows the teacher to present a true picture of a given problem.

Use of the computer for gaming and simulation represents a valuable and exhilarating instructional experience for both student and teacher. Through computer simulation the student can experiment and gain experience, test alternative solutions, and observe answers to "what if" type questions. Computer gaming and simulation serve to extend his exposure to laboratory experimentation and decision-making.

Table II illustrates some of the problems in various subject areas that can be treated through the use of digital computers. To use the digital computer, students must learn a programming language. Their programs can be executed on the college's computer, if it is available, or they can be sent out to be processed. Or, typewriter-like terminals connected to a computer might be used. These have a programming language that can be learned in a few hours.

TABLE II

MATHEMATICS

Approximate the real root of an irrational equation by Horner's Method, Cardano's Formula, etc.

Find the coefficient of correlation of two sets of data.

Approximate a definite integral by Simpson's Rule (whether integrable or not).

PHYSICS

Calculate maximum range and height of a projectile.

Predict resultant temperature in heat transfer experiment.

Simulate laboratory experiment on torque, gas laws, Atwoods Machine, Kundt's Tube, etc.

CHEMISTRY

Simulation of gas laws experiments.

Balancing of chemical equations.

Half-lives of radioactive isotopes.

MUSIC

Transpose a given piece into a given key.

Create harmony for given melody.

HOME ECONOMICS

Scale dress sizes.

Scale recipes.

Cataloging of recipes.

NURSING

Teaching techniques of:

Computer techniques in patient care.

Clinical laboratory application.

Computer-prepared nursing notes.

MECHANICAL TECHNOLOGY

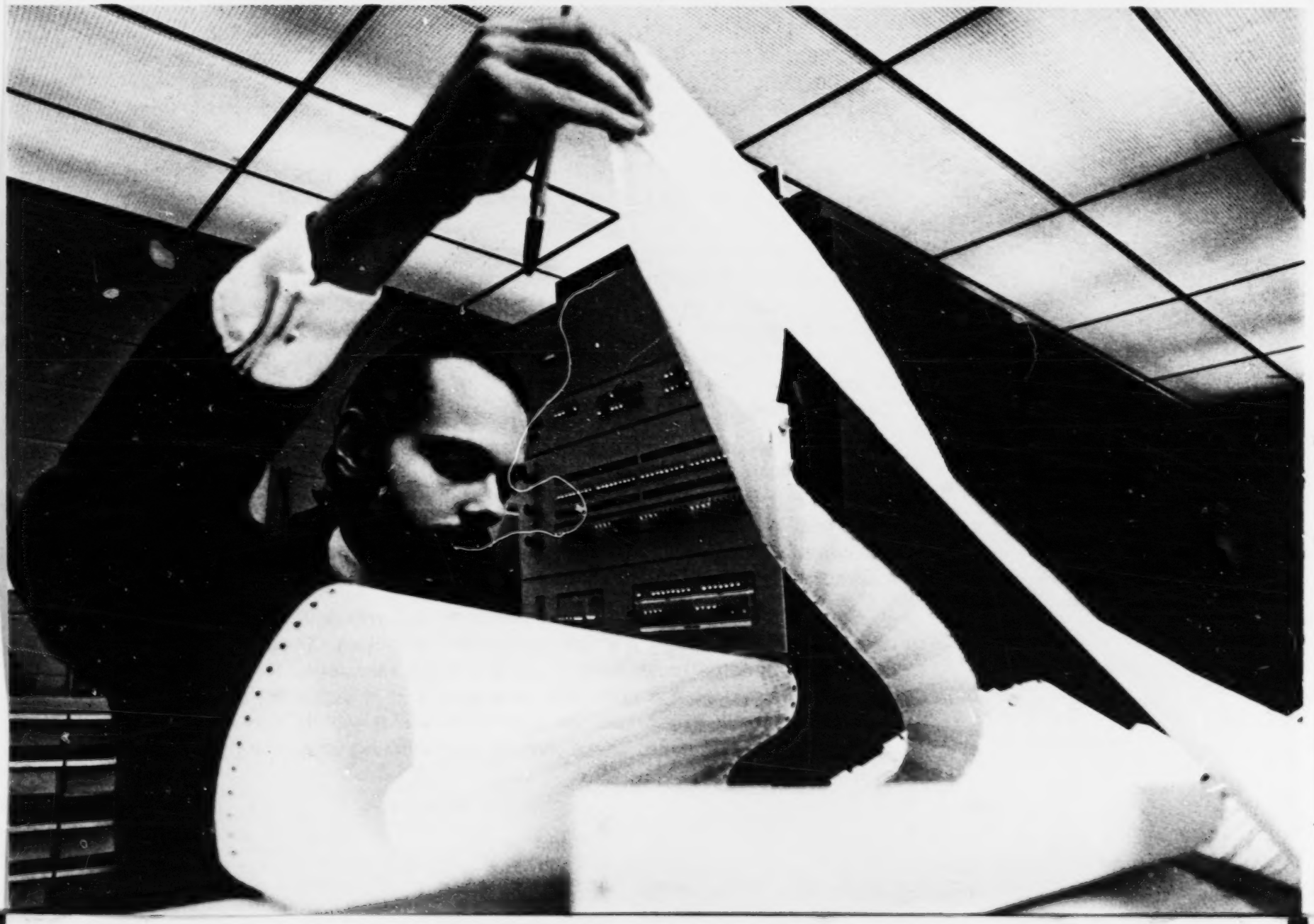
Preparation of coded instructions for numerical control machine tools.

ELECTRICAL TECHNOLOGY

Circuit design using Electrical Circuit Analysis Program.

LIBRARY SCIENCE

Teach techniques of mechanized library procedures.



III. Education for Data Processing Occupations

Beware of first getting a computer system and then trying to find a way to put it to work.

Beyond providing computer literacy courses for their students and offering education in computer programming skills needed by non-data processing majors, junior colleges may offer specialized educational programs for those intending to work as professional data processors. This section considers specific areas of employment within the data processing industry and outlines curricular matters appropriate for junior colleges.

Some Data Processing Jobs

Job descriptions for data processors come in a variety of sizes and shapes. Some brief descriptions are given of a number of jobs in industry as a basis for the curricular considerations that follow.

Business Applications Programmer

Business applications programmers assist higher level programming personnel in the analysis of detailed business application systems specifications and in the preparation of program instructions. A business applications programmer is one who prepares computer programs that perform commercial applications. Such applications include producing payroll checks and statements, customer billing and accounts receivable, inventory control and file updating, and, in some progressive firms, equipment scheduling, production control, and systems simulation. Most often, programmers working to effect applications like these need little mathematical training beyond the junior college level. This is particularly true for entry-level positions.

Scientific Applications Programmer

Scientific applications programmers convert scientific, engineering, and other technical problem formulations to formats processable by computer. They resolve symbolic formulations, prepare logical flowcharts and block diagrams, and encode resolvent equations for processing by applying knowledge of advanced mathematics, such as differential equations and numerical analysis, and understanding of computer capabilities and limitations.

Systems Software Programmer

Systems programmers or software programmers, as they are often called, develop, maintain, and revise computer operating systems and programming systems. This work is very technical in nature, requires a high degree of skill in using machine-oriented programming languages and a thorough understanding of computer system hardware functions and capabilities. Systems programmers work at developing applications programming languages, compilers, utility programs, and special purpose programming routines known as macros.

Business Systems Analyst

A business systems analyst analyzes a variety of business information processing problems such as the development of integrated production, inventory control, and cost analysis systems. Systems analysts confer with department heads to ascertain specific output requirements for management reports and to analyze alternative means of deriving input data to select the most feasible and economical method of implementing a proposed system. They also prepare process flowcharts and outline specific implementation matters—including audit trails, verification points, and operational procedures.

Computer Operator

Computer operators engage in activities within the computer facility. These activities include manipulating and operating computer console devices, switches, and typewriters as well as operating such peripheral computer equipment as line printers, tape drives, disk drives, card readers, and other computer room equipment. Operators of modern computer systems are frequently required to make elementary operating decisions based upon information presented to them by the computer system and may be called upon to handle routine matters involving job control language.

Unit Record Equipment Operator

Unit record equipment operators work with electromechanical punched card processing equipment. Their work requires that they prepare externally wired control panels and operate unit record equipment. They may be involved in the design of punched card data processing systems and applications including the design of punched card records and files.

What Can Junior Colleges Teach?

There are three types of occupations in the data processing profession for which junior colleges can best prepare students to seek work on an entry level basis. These are the business applications programmer, the computer operator, and the unit record operator. The first two of these can be effectively trained by junior colleges and should be, in view of the relatively heavy industry demand for commercial programmers and for qualified computer operators. The third, unit record operator, can also be effectively prepared. However, preparing students as unit record operators is preparing them for limited career opportunities. The junior college graduate will quickly discover that growth in his chosen career of data processing requires, as a basic minimum, skill as a computer programmer. Acquiring computer programming skills in junior college, as opposed to specialized skills in unit record equipment operation, would nevertheless have prepared him to accept an entry level job on a data processing staff as a unit record operator inasmuch as persons with any training in data processing can quickly learn to operate unit record equipment. For these reasons, this discussion will deal chiefly with the first two occupations.

Who Should Learn Data Processing?

A number of junior colleges make serious efforts at pretesting and otherwise evaluating those students who want to study data processing. A number of test devices are used including IBM's Programmers Aptitude Test, and individual scores from such instruments as the Scholastic Aptitude Test and the Strong Vocational Interest Blank.

There is little reason to limit enrollment in the data processing program to only those students who exceed a minimum score on any test or measuring device now available. Current research indicates little or no relationship between scores attained and academic success in a college discipline. Introductory coursework is a more realistic screening device than any

ability test now available. It can serve two purposes: it provides computer literacy to those who would like to major in data processing but who may nevertheless be incapable of mastering the subject matter; and it gives the student an opportunity to demonstrate that he can master the subject matter, perhaps in the face of test scores that suggest that he cannot.

The quality and standards of the data processing curriculum need not be reduced so that every student can complete the program successfully. But all students should be given the opportunity to try the program, without prejudging based on test scores that have not demonstrated their value as predictive measures.

Business Applications Programmer

The prevalent structure of data processing training in junior colleges today consists of two-year technical programs leading to an associate degree. This training consists of the equivalent of sixty or more semester units of computer-related and peripheral or general education courses. At this point, similarity among junior college programs ends, and one can find a diversity of course offerings all producing that person typically referred to as a "programmer."

The strengths and values of data processing programs vary. A direct relationship can almost always be found between a school's commitment to a strong program and the preparation of competent data processing graduates. What constitutes "commitment" to a strong technical program? Establishing sound behaviorial objectives; instituting pertinent curriculum choices; acquiring and retaining a technically competent staff; and providing adequate equipment and physical facilities are all evidence of a school's commitment to a quality program.

Objectives

Realistic objectives for a program to train the business applications programmer would include: providing the necessary base of technical skills for the graduate to get a job as a trainee; and providing the educational foundation to enable the student to master new equipment, systems, and programming languages as changes in data processing technology dictate during his career.

Determining what constitutes a nucleus of technical skills and what the foundation for growth will be can be greatly facilitated by using surveys and advisory committees from local business firms; the expertise of the staff, derived from their own experiences and feedback from students; local data processing organizations; and national publications in the field. A broad base should be engaged so that local needs do not dictate content in such a way that graduates' geographic or occupational mobility are restricted.

When designing any data processing curriculum, the college is obligated to make the student more than merely literate in the field. Technical details of problem solving and computer programming are certainly necessary. Even more important, the student must understand the problem he is attempting to solve. While a portion of the curriculum must be involved in the detailed operation of various programming language instructions or statements, these should be used only as a tool in helping the students approach problems clearly and logically. The application of specific programming techniques is the key here. Mimicking solutions to problems provided by teachers is of no real educational value.

The curriculum should at all times be flexible, allowing for multiple entry and exit points for the student. As data processing education is an unending process for everyone in the field, a college should not attempt to lead the student to believe that he is committed to a two-year terminal program. Once his needs in a specific area have been met, he should be encouraged to put his skills to work in the field.

Computer-related objectives determined by those technical skills necessary for business applications programmers include:

1. Understanding computer hardware concepts and capabilities
2. Problem solution utilizing flowcharts, decision tables, and fundamental processes of analysis
3. Ability to code problem solutions in one or more programming languages
4. Understanding software concepts such as operating systems, multiprogramming, time-sharing
5. Basic concepts of communication techniques: remote operations and on-line, interactive, and batch processing techniques
6. Data file organizations and access techniques
7. Basic understanding of a business "system" and its integration with other systems.

These objectives provide the graduate with a foundation upon which he can build his future career, and fortify him with basic entry-level skills. The Association for Computing Machinery, in its policy statement of May 1969 concerning minimal guidelines for private data processing schools, indicates that the single most important basic skill for winning an entry-level position as programmer consists of the ability to code programs from flowcharts, block diagrams, or other equivalent program definition documentation. In addition, the Association points out, the beginning programmer should be able to: identify and correct errors in his programs, recognize successful output, design and document simple programs, and communicate with co-workers and supervisors.

Continual re-evaluation of objectives and skill requirements is necessary in a field with the rapid technological change and dynamic industrial growth. This re-evaluation can be accomplished using the same techniques, generally, that are used in initially determining the objectives of the program, namely, use of surveys and advisory committees, feedback from students, and trade literature. In addition, information obtained from the operation of a comprehensive cooperative education program will be found invaluable as a source of information concerning changes in local needs and in the data processing industry in general.

Curriculum Design

Curriculum objectives logically evolve from educational objectives. They must be constantly evaluated, and modified where necessary, to keep pace with industrial needs. Curriculum offerings in computer related courses should include:

1. Two years of programming with a knowledge of at least two computer languages. One language (predominantly used in areas in which graduates will seek their initial jobs) should be emphasized. Familiarity with other languages would be helpful. Junior college data processing graduates will fare better with concentrated, in-depth skills in one programming language than with exposure to a wide variety of programming languages with in-depth skills in none of them.

It is often argued that some knowledge of an assembly language is essential for anyone to be a successful applications programmer using a high-level language such as COBOL. This may justify at least one course in assembly language programming.

Of the various high-level programming languages most widely used in industry today, COBOL seems to be the most viable alternative for the junior college. FORTRAN, being more typically useful in scientific and technical applications, will be of very limited value to the newly graduated business applications programmer. PL/1, recently showing increasing popularity, combines features of both COBOL and FORTRAN, and should be considered for inclusion in the program. Many educators look upon RPG as a good vehicle for introducing basic concepts of computer use in data processing systems, and of data file organization and accessing techniques.

Although these considerations and the desire to make graduates as flexible as possible may indicate some exposure to several programming languages, the best service a junior college can provide is an in-depth programming skill in one language. We recommend that several courses in one language be offered by the college, each one concentrating upon increasingly complex applications involving that language. Junior colleges with large data processing programs may find it feasible to offer each student a choice of language in which he will specialize. In this situation, a student could take a general introductory course in data processing, another in basic concepts of computers and computer programming, and then take two or three programming courses in applications using the programming language of his choice. Smaller junior colleges probably will be unable to offer such a choice, and will, out of economic necessity, limit their concentrated programming offerings to the language most often found in their geographic area.

2. At least one semester in mathematics stressing skills most widely used in commercial data processing applications.

3. One semester of logic and algorithm design related to solution of problems by computer, emphasizing flowcharting, decision tables, and table search techniques.

4. Operating systems concepts, job control functions, and teleprocessing techniques. These topics should be the content of a separate course rather than be taught within programming courses.

5. A course covering processes used in analysis and design of business systems. Such a course should emphasize the role of automated data processing within the information system serving the business organization.

6. Courses in the data processing curriculum should include investigations into those areas relating to business applications. These might include banking, manufacturing, transportation, utilities, government, and insurance. In order that students develop the ability to analyze applications in these areas, these courses should include:

a. Accounting b. Statistics c. Economics
d. Management e. Communication Skills

7. Field experience that allows the student to do programming work in a local firm, with direct supervision by firm representatives, and periodic evaluation by instructor visitation and seminar. There is great value in operating a cooperative education program. Such programs provide the student with realistic training and serve as a link with the community. They provide information to the data processing program that can be used for re-evaluation and program modification.

Cooperatives should provide realistic pre-employment opportunities for students and will provide the school with immediate feedback on the relevance of its program. Three types of cooperatives are currently used, all of which are very effective. In the Alternate Semester Plan, a student attends school full-time one semester, and works full-time the next. In the Parallel Plan, a student is registered for a part-time load and concurrently holds down a part-time job. The Extended Day Plan has the student employed full-time during the day and attending school part-time in the evenings.

If possible, a college should offer the plan students choose from among the three. This kind of flexibility will go a long way toward meeting individual needs.

Computer Operator

Characteristics of modern computer equipment and operating systems have introduced a new dimension in operational complexity over that existing a few years ago. Operating a computer in a multi-programmed and/or time-shared environment requires considerable talent and attention to detail. Communication between the computer and the operator is so extensive it demands a highly skilled operator be continuously at the console.

Such stringent operating requirements were not demanded by previous equipment generations. Most operator training programs have concentrated on physical dexterity in mounting and demounting tapes and disks, changing printer forms, and other routine manual tasks. Although these functions are still needed, the present day operator must have a thorough background in operating system control to provide maximum computer through-put.

Objectives

The significance of the changing job duties of the operator are of prime concern to the junior college. No longer should a person experiencing difficulty in programmer training shift to operator training, a trend that was prevalent in the past. Computer operators today must exercise a number of skills. Most of these are distinct from those required of computer programmers, though no less demanding. They should be able to:

1. Operate all types of equipment typically found in modern computer installations. This would include mounting tapes and disk packs and operating line printers and card reader-punches. These activities require only a little more skill for working modern computer installations than for second generation. The skills to follow, however, go considerably beyond these basic functions. The operator must be able to:

2. Understand operating systems, including the difference in operating techniques among different systems

3. Understand basic files organizations and accessing techniques

4. Interpret console messages and take appropriate action

5. Prepare job control language specifications for applications programs to be executed on the computer system as configured at the time of execution

6. Execute standard computer utility programs including sorts, file duplication, listings, dumps, and activity statistics.

Curriculum Design

At the present time, there are only a few junior colleges offering specialized curricula in computer operations. The skills required suggest the following topics for inclusion in such a program.

Data and File Organization Techniques

Equipment Capabilities and Functions
Input-output devices
Central processors and consoles
Channels

Configuration and Control of Operating Systems

Console Operations
(typing skills assumed) and
Use of Operations Manuals
Peripheral Device Operation
Physical File Handling and Maintenance
Magnetic tape
Magnetic disk

Job Control Language
Utilities Execution
Computer Room Practices

The difficulties of providing an adequate training program for the type of computer operator currently in demand should be thoroughly analyzed prior to commitment to such training. As mentioned above, the skills now necessary for this operator are of a different type and magnitude than those needed in the past.

The student in training must be provided access to the computer and be allowed to communicate and interact with the operating system. The system should have capabilities for conducting concurrent operations in a multi-programming environment. This facet of training is extremely important and should not be overlooked. The type of computer configuration, and the uses of the computer in the school, could conceivably preclude the effective use of the computer for this type of operator training.

If the school cannot provide the necessary facilities and instructional personnel for operator training, the use of a cooperative program with a local installation could be considered. The school could provide classroom instruction in operating system fundamentals, job control, use of manuals and run books, and arrange for the local installation to provide the facilities and supervision for hands-on implementation of theory. The prime requisite for a high-quality program is providing an environment where the student can do what he will need to do to function effectively in modern installations.

Unit Record Equipment Operator

A unit record equipment operator works with electromechanical punched card processing equipment. He prepares externally wired control panels and operates unit record equipment in the production of data processing work. He may be involved in the design of punched card data processing systems and applications, including the design of punched card records and files.

Although in general we believe that colleges should not offer degree programs in unit record applications, some colleges may find need for specific courses treating unit record processing. In view of recent advances in small-computer and card-file systems, junior colleges may offer opportunities for students to prepare for work in small, card-oriented installations.

Since unit record equipment was the direct ancestor of the modern computer and some of the skills used in unit record operation provide a basic introduction to computer concepts—wiring unit record equipment, for example, is somewhat analogous to programming a computer—unit record training is included in some data processing curricula.

Unit record operation may still be a useful skill for some students, but since computers have become smaller, less expensive, and more versatile, students can learn computing directly. There is no question that while unit record training may be a usable skill now, it will become less marketable as computers move into areas now occupied by unit record equipment.

Unit record data processing techniques should not be taught by a junior college simply because it can afford no other kind of data processing equipment. Nor should these techniques be taught only because the teaching faculty is able to teach them. Subjects must be governed by job opportunities available for graduates, not by the capability of the teaching institution. The local employment picture should influence the degree of emphasis placed on unit record training. If there is a strong demand for unit record personnel, schools will tend to meet the demand by handling training as a terminal rather than introductory program.

Unit record concepts and introductory computer concepts can be and are taught at the secondary school level. Therefore, consideration should be given to close articulation with local high schools to develop a program which leads into the community college curriculum. One obvious advantage of this articulation is that the community college could increase the breadth and depth of its program.

Objectives

Skills required of personnel working in unit record or card-oriented installations include the ability to design punched card data files, prepare control panels for electromechanical punched card processing equipment, and the operation of such equipment. Because of the recent introduction of small-scale computers that process card files much more effectively than electromechanical equipment, graduates seeking employment in card file-oriented installations should also have computer programming skills as required for that computer equipment. At this time, report program generator languages are the most widely used.

Curriculum Design

A curriculum to serve these objectives need not require more than two or three courses, and can be offered in conjunction with the business applications programmer curriculum. We wish to repeat at this time that the skills needed by individuals working in card-oriented data processing installations or unit record installations are almost all acquired in the

process of completing a comprehensive curriculum in business applications programming. The curriculum outlined below reflects topics that can be directly associated with working in such installations.

1. Punched card record and file design
2. Unit record equipment operations
   a. Electromechanical equipment
   b. Computer-oriented punched card systems
3. Control panel wiring
4. RPG programming, card-to-printer applications.

Non-Technical, General Education Subjects as Part of the Data Processing Curriculum

If one of the objectives of a junior college curriculum in data processing is that of preparing the graduate to be as versatile and as productive a person as possible, then students should expect to study subjects not necessarily related directly to developing specific data processing skills. Most agree that coursework in communications, English, accounting, statistics, mathematics, business organization, and economics is necessary to the development of a well-rounded data processing employee.

Some comment about mathematics as a requirement for junior college data processing graduates is in order at this point. Many junior colleges establish specialized "data processing mathematics" courses and require this for all data processing majors as if, somehow, there is a special set of mathematical skills that are particularly appropriate for data processing and computer programming. Elementary algebra skills required by business applications programmers are universal in nature. So-called data processing mathematics courses remain basic algebra courses despite their name. There is no clearly defined set of specialized mathematical skills that computer programmers require save a working knowledge of non-decimal numbering systems and development of algorithms. These matters can be and usually are adequately treated in introductory courses in data processing and computer programming. The remaining mathematical skills can be learned from the regular course offerings in algebra. These skills should be equivalent to two years of high school algebra and should prepare students to enroll in an elementary college statistics course.

Staff Requirements

A versatile, technically competent staff is absolutely essential to a sound junior college program in data processing and computer programming. While providing the faculty with the time and opportunity for growth and skill, the attainment of new skills is critical. Constant study and involvement is necessary if the staff is to avoid stagnation and keep abreast of new developments.

Academic Requirements

Academic requirements of data processing teachers will vary from one community college to another. Typically, one would expect at least a bachelor's degree, and often a master's degree is preferred. In terms of academic discipline, the fields of business and mathematics predominate. In some cases, particularly for part-time teaching positions, industrial experience may substitute for academic training.

Experience

The ideal data processing faculty member at a junior college should have two years of programming experience, including demonstrated competence on the computer being used as the teaching vehicle. Assemblers should be competent to write programs in the assembler language of the vehicle computer. Compilers should know at least two high level languages, and should be aware of special-purpose languages in sufficient detail to be able to discuss types and uses with students. The faculty should be competent in the particular executive or operating/control system installed on the computer in use, and should be able to distinguish functions and capabilities of various systems for students.

Chances are that most junior colleges find it nearly impossible to locate faculty with all these qualifications. As a result, they look to a number of inservice and pre-service training programs geared to helping faculty members in business and mathematics to acquire the necessary technical skills to teach data processing. There is no question that the acquisition of competent staff is one of the most vexing problems faced by the junior college intent upon launching an educational program in data processing. The training programs described in Chapter I' of this booklet need considerable expansion if the national need for data processing instructors is to be met.

Hardware Requirements

Though there is a multiplicity of computers and manufacturers from which to choose, it is not within the scope of this publication to recommend a particular model, vendor, or approach. The school must give careful consideration to total institutional use of the computer and its particular requirements to properly evaluate the most suitable unit, or to determine the suitability of utilizing some other computer on a time-shared basis.

However, one consideration should be foremost. If a junior college chooses to offer a technical program for business applications programmers and computer operators, it must make available the computer generation predominantly in use in the data processing industry. To attempt to train programmers for today's market with yesterday's equipment is hardly satisfactory, and cannot produce the training level required. A commitment to train must include a commitment to proper computer facilities—anything less will not suffice. Not only is access to a modern computer facility imperative, but so too is exposure to an operating system environment. If these requirements cannot be economically justified and provided, the institution should not offer a program. This would be a better alternative than offering inadequate training.

Hardware Processing Capabilities

A computer system able adequately to provide the minimal learning experiences must be able to provide a number of systems, languages, and file processing capabilities. They would include: COBOL, assembly language, job control language, disk file processing, utilities, and operating system.

Hardware considerations will be based primarily on the institution's commitment toward integrating the computer throughout the institution. The data processing curriculum will not require that sophisticated equipment be located on site, but rather that the students have access to this equipment. This can be provided by a terminal connected to a regional center, or a service bureau processing programs on a batch basis.

"Hands-On" versus "Hands-Off"

At almost any gathering of data processing educators, discussions concerning whether or not students should execute their own programs inevitably arise and become heated. The basic alternatives are these: first, allow all programming students to execute all of their programs themselves; and second, allow no programming student to execute his own program, but require submission of programs to the data processing or computer center. Programs would all be executed at one time and the results returned to students after a wait ranging from a few minutes to a few days. Compromises and modifications involving these basic alternatives are countless. One might, for example, allow students to execute their first program, or allow them hands-on at specified times during the day, or allow them to enjoy immediate execution of their program as they watch the operator through a window.

Data processing managers, and particularly computer center directors, can build a strong case against hands-on execution of student programs. Convincing arguments in favor of hands-on training have also been worked up.[1] Within each institution, both the administrative and the instructional staffs must be consulted and their recommendations presented to top management levels for a policy statement.

Some institutions employ hands-on and closed-shop methods. The majority of students, after some limited hands-on experience early in their training, submit their programs to the computer center where the programs are run in a closed-shop environment—generally geared to a 24-hour turnaround schedule. This means that while some students have access to the computer on a controlled basis, the large numbers of students do not.

In colleges, sometimes an ideal solution is available. The attachment of a second card reader (it has not been found necessary to include a card punch) and a second printer to the system alleviates virtually all concern about open or closed shop. This second set of card input/output units is generally placed in a room adjacent to the computer. The students have unlimited access to these units. When this technique is used, the computer must be able to support at least two partitions of its main storage to accomplish satisfactory service for both instruction and administration.

Acquiring the Hardware

Exactly how any one junior college goes about getting the hardware capability it needs depends, of course, upon the particular circumstances of the school. The only significant advice valuable here is beware of the widespread practice among educational institutions (and commercial ones too, for that matter) of first getting a computer system and then trying to find a way to put it to work.

We have observed that educators, and junior college people in particular, become so quickly convinced of the desirability of computer systems that they leap to a solution—namely get a computer—before they give the problem of what they will use it for a good review. The closing part of this booklet describes the steps involved in getting started in the data processing education business. Obtaining the necessary equipment is one of the last things to do.

Once all the preparatory work is finished, and it has been established that the junior college *should* offer data processing, it remains to make the computer system available to the program. There are a number of alternatives open for doing this.

[1] Clark, John R. and Tilton, Theodore. *Comments and Curricula Related to Third Generation Data Processing and Specifically IBM Systems/360.* October 1967. California State Department of Education, Sacramento, California. October 1967.

Leasing

Most junior colleges lease their computer systems. Computer manufacturers make their equipment available, usually with an option to buy or lease. Leasing avoids a considerable capital outlay on the part of the college and makes it easier to modernize the installed system as technology advances require. However, if the computer system is to be kept without change for a number of years—from four to eight, depending upon the manufacturer—the college would be better off purchasing the equipment.

A number of companies buy computers and make them available to institutions through lease. Usually, the rental charges are less than the cost of leasing equipment directly from the manufacturer. This is possible because the leasing company amortizes the original cost of the equipment as purchased from the manufacturer over a longer period of time than the manufacturer would have leased the system itself to the user. Companies making equipment available on a lease basis most often require that the college agree to keep the equipment for a longer minimum time span than would be expected by the manufacturer in a leasing agreement. This means that the college would pay less per month, but would be required by the contract to keep the equipment longer, thereby limiting the college's ability to change equipment quickly.

Purchase

If the college is certain it will retain the computer system for a long period of time, the purchase option becomes more favorable than leasing.

Remote Job Entry

The term "remote job entry" refers to the technique of submitting work to a computer system from a location somewhat removed from the central processing unit and main storage facilities. In Remote Job Entry (RJE) systems, a computer user may be provided with a card reader-punch and a line printer. These devices are used as input-output units to a computer system some distance away. The input-output device, usually called a terminal, is often connected to the main computer by means of telecommunications lines.

Remote job entry is becoming popular with small institutions that want access to large systems but cannot afford them. Many community colleges consider small computer systems or terminals, which are designed to communicate with a larger computer system at another campus within the district or within another district, a useful approach to making computing power available to their program. This approach provides the smaller colleges with the full power and language facility of the large system.

On-Campus Systems

Assume that a community college decides to rent, lease, or purchase its own computer system. If the system is to be used for college administrative purposes as well as for the educational data processing program, as is most often the case, some consideration should be devoted to the variety and quantity of hardware devices to be made available. An earlier publication of the American Association of Junior Colleges, *The Computer and the Junior College,* treats this matter in some detail;[2] readers are urged to examine that document.

What Junior Colleges Should Not Teach

A two-year junior college program is entirely adequate for training a business applications programmer; a one-year program is probably enough for computer and peripheral equipment operators. Some junior colleges say their programs produce "scientific programmers" and "system analysts." Although exceptions are possible, it is generally unfeasible to presume that

[2] Hill, James and Sedrel, Roy. *The Computer and the Junior College.* American Association of Junior Colleges, Washington, D.C., 1969.

junior colleges can provide their students with the proper skill levels required of these positions.

Scientific programmers work in industries such as aerospace, engineering, electronics, biomedicine, and physics to solve the special problems those disciplines encounter. Without specialized training, the programmer could not understand how to use the computer even if he knew the techniques of use.

The system analyst, although business oriented, also requires more knowledge of business skills and background course material than is available in a two-year program. This position usually requires a baccalaureate degree, and, in many cases, experience in programming and/or general exposure to the business world for a period of years.

A number of other computer-oriented occupations normally require a four-year academic program. These include the systems software programmer, scientific applications programmer, and business systems analyst/designer. It is important for a business applications programmer trained at a junior college to have a course in systems software and one in systems analysis and design. A person preparing for specialization in occupations involving those topics must have considerable familiarity with them, as well as with a wide range of related subjects. The depth and breadth of knowledge required for preparation in these fields can rarely be provided in a two-year program.

Enrichment Programs

The greater portion of this booklet is devoted to considerations dealing with providing an educational program designed to prepare junior college students to seek entry level positions in data processing installations as business applications programmers and as computer operators.

In addition to preparing students for entry level jobs, the junior college can and should offer coursework for professionals and others in the college area. New data processing methods brought about by changing computer technology create serious educational deficiencies for practitioners. Systems analysts, programmers, and data processing managers, trained through experience on the job, or through vendor and college courses "a computer generation" ago, have an urgent need to keep abreast of technical and managerial advances in their field.

The expanding job responsibilities of data processors, the increasing demands on data processing departments, and the expectations of new generations of equipment and applications call for continuing education and re-education as the only antidote to professional obsolescence—and in many cases, system failures. The growing reliance on data processors as advisors and interpreters as well as implementers of computer-based systems urge the development of dynamic educational programs which will embrace computer managers as well as technical personnel.

Only the largest industrial firms can afford to offer adequate in-house training programs for their data processing personnel. Most companies rely on university extensions, computer manufacturers, professional and industry associations, and educational consulting firms for this type of training. Separate pricing of educational services by the computer manufacturers has served to bring into focus the real costs of such training which was apparently offered "free" by the vendors, while really hidden in equipment rental agreements.

The community college is in a unique position to offer advanced data processing courses in systems, programming, computer management, and special applications tailored to satisfy local needs. These "professional" courses can be taught by qualified local experts from industry in the afternoon, evenings, or on weekends. Special offerings to meet industry needs might be arranged, with persons given time from work to attend.

Coursework should include study of specialized programming languages dealing with such topics as numeric control, channel programming, and advanced work in operating systems. In addition, a variety of applications programming languages may be offered as short-term subjects for competent programmers. Condensed courses in the use of specific languages or techniques should become a regular part of the curriculum whatever the size of the college. Frequently, courses are designed to cover a multitude of topics. This forces the student interested in only one or two of these concepts to waste his time listening to what he already knows in order that he may gain insight into the specific topic of his interest.

The specific subjects to be taught as part of the enrichment or continued education program should be determined with consultation of advisory groups, work experience feedback, and examination of current trade literature. The continued education program needs continual re-evaluation to meet the needs of the junior college community. The value of advisory committees and work experience programs as sources of information for this on-going process cannot be overemphasized.

Not only do community colleges gain in prestige from enrichment offerings, but they also gain the appreciation of local industry. They provide low cost training, perhaps not obtainable anywhere else, for those companies largely responsible for the financial support of the college. The entire community benefits.

IV. Organizational Considerations

Data processing education is an unending process for everyone in the field. A college should not attempt to lead the student to believe that he is committed to a two-year terminal program.

Curriculum and personnel are at the heart of the organizational effort. Uniformity of organizational patterns among institutions is no more a requisite to effective instruction than is uniformity of objectives. However, an organization structure that does not complement curricular and personnel objectives may prove ineffective in reaching established goals.

Traditionally, educational efforts have been organized by functional area (subject matter); this is illustrated in *The Computer and the Junior College.*[3] Though these organizational patterns have proven useful, they tend to reflect more of a concern for personnel administration than for curricular management. In view of recent trends toward broadening students' educational experiences, it may be more desirable to think in terms of a systems approach to curricula management. Such a structure could be devised by expanding functional departments to include, for the purpose of curricular planning and evaluation, representatives of other disciplines. Separate but overlapping structures could be maintained, one for personnel administration and one for curricular management.

To the extent that they are qualified, non-data processing specialists should be involved in data processing curricular planning and evaluation. As suggested in the introduction, the environment in which the data processing graduate will work demands an increasing awareness of additional potentialities for computer applications. Necessarily, then, the curricular plan should include studies other than those exclusively technical in nature. The departmental structure, modified by the inclusion of faculty from related areas, appears to be the most promising assurance that the educational program will be well balanced between general and technical education. The data processing curriculum may be viewed as a project or task and the curriculum committee as the task force. Decisions relating to curriculum are more likely to reflect a concern for factors other than just those associated with the discipline in question. By reducing the number of *ad hoc* decisions in curricular matters, the administrator would be making significant progress toward an integrated approach to institutional management.

By encouraging faculty from other disciplines to participate in data processing education, administrators will hasten the time when students in many programs of study can benefit from computer-related instruction. The mystique commonly associated with computers tends to dissipate as faculty become more familiar with the potential for and limitations of applications in their respective fields. As an added benefit, faculty normally acquire greater empathy for matters which are peculiar to the various other educational activities.

[3] *Ibid.*, p. 10.

Departmentalization by discipline as an effective option for organizing instructional activities need not be ruled out. Functional organization structures are today the overwhelming choice of most institutions of higher learning. However, it may prove more effective in the long run to make a distinction between personnel administration and curricular management, and to provide the most appropriate vehicle for both in the overall organization structure. Though the activities are interrelated, curriculum administration is more encompassing. It follows that an enlarged area of concern should be managed by persons whose backgrounds are appropriate to the task at hand. Personnel management is, in reality, one important factor in curriculum management, but the two are by no means synonymous. Other considerations such as program objectives, facilities and equipment constraints, student preparedness, and employer needs are cited in this publication and in *The Computer and the Junior College.*

The following generalizations relating to organization may assist the administrator in evaluating the merits of this line of thought. An organization is one means by which the institution attempts to attain its educational goals. Each institution must, in the end, decide for itself how most effectively to work toward them. The advantages usually advanced in defense of departmentalization by subject matter are:

1. It promotes a closely-knit, cohesive faculty-student relationship.
2. It groups subject matter specialists together, and thus contributes to professional growth and an increase in each faculty member's proficiency and interest.
3. It is easier to coordinate and evaluate efforts inasmuch as attention is directed primarily toward departmental problems.
4. It facilitates communication among faculty and students who share the same types of problems.

Conversely, critics of departmentalization cite as disadvantages the attributes which are enumerated above. The arguments against organizations characterized by discipline separatism are most often associated with those who advocate an ordering of institutional goals and broader educational experiences for students. Some of the disadvantages most often noted are:

1. It does not stimulate the development of instructional programs designed to make the student aware of the interrelated nature of his environment.
2. It leads to insularity and inflexibility of departmental processes.
3. It tends to favor, albeit unintentionally, faculty and departmental objectives over institutional and curricular objectives.
4. It results in an unhealthy competition among departments for the student's time in school.
5. It inhibits personnel updating in related subject matter fields.
6. It fosters empire-building and impedes the administrator's efforts to introduce innovations.

Another reason for modifying traditional departmental structures is to improve curriculum evaluation. Involving faculty whose preparations are in subject areas other than data processing, for instance, provides additional internal control at the peer level. Two significant benefits may be realized as the result of an interdisciplinary or systems approach to curriculum management. Data processing students will receive a better-balanced exposure to technical and general studies, and students in other disciplines are better assured of receiving courses in computer education that are geared to their needs.

One other aspect of curriculum management bears mentioning. Data processing education college-wide is a singular program, even though individual departments may offer courses tailor-made to their students' programs. The long-run interests of the institution will be best served if the total effort is coordinated by the individual responsible for the data processing degree program (assisted by his curriculum committee). This approach should go a long way toward avoiding problems associated with redundant course offerings and less-than-optimal utilization of personnel and facilities.

Separation of instructional and administrative responsibilities is advisable. Teaching and administering an educational program is a full-time assignment. The field of data processing, subjected as it is to technological advancement at an astonishing pace, requires that an individual's complete attention be directed at curricular implications of change. Instructional personnel should report to an individual other than a director assigned to administrative activities, thus better assuring that the needs of both the educational and administrative programs will be well served.

The factors influencing the choice of an organization structure are many. Foremost among these are the objectives and policies of the educational and personnel programs. A distinction should be made between managing personnel and managing curricula; an organization for administering both in the most effective manner should be established. The organization structure, it should be remembered, is an important vehicle to the college administrator. Through it, he may more effectively plan, direct, and evaluate educational programs. To the extent that his organizational structure is appropriate for the tasks at hand, he will realize success in his efforts.

Figures A and *B* illustrate some of the above remarks. *Figure A* shows

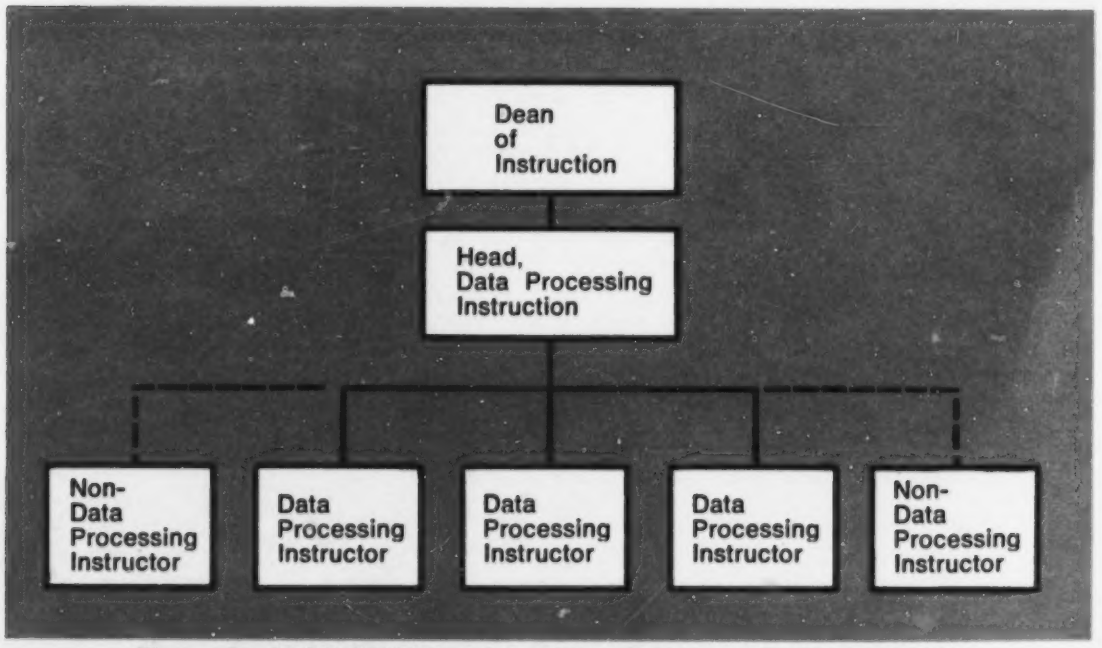


Figure A: ORGANIZATION FOR DATA PROCESSING INSTRUCTION

the organization of a data processing department as a typical division of instruction within a college organization. This department, responsible to a dean of instruction or a similar authority, is staffed with a number of data processing instructors. The instruction staff is supplemented with faculty members outside of the data processing department. These instructors provide valuable inter-disciplinary considerations to the data processing program.

Figure B shows the sequence of events involved in making changes in the established curriculum. Requests for changes, emanating from a number of sources, are reviewed by the data processing staff, augmented by members of other instructional disciplines directly implicated in the change. Their recommendations are considered by the Data Processing Industrial Advisory Committee. The recommendations of this body, in turn, are sent to the college curriculum authority who implements them.

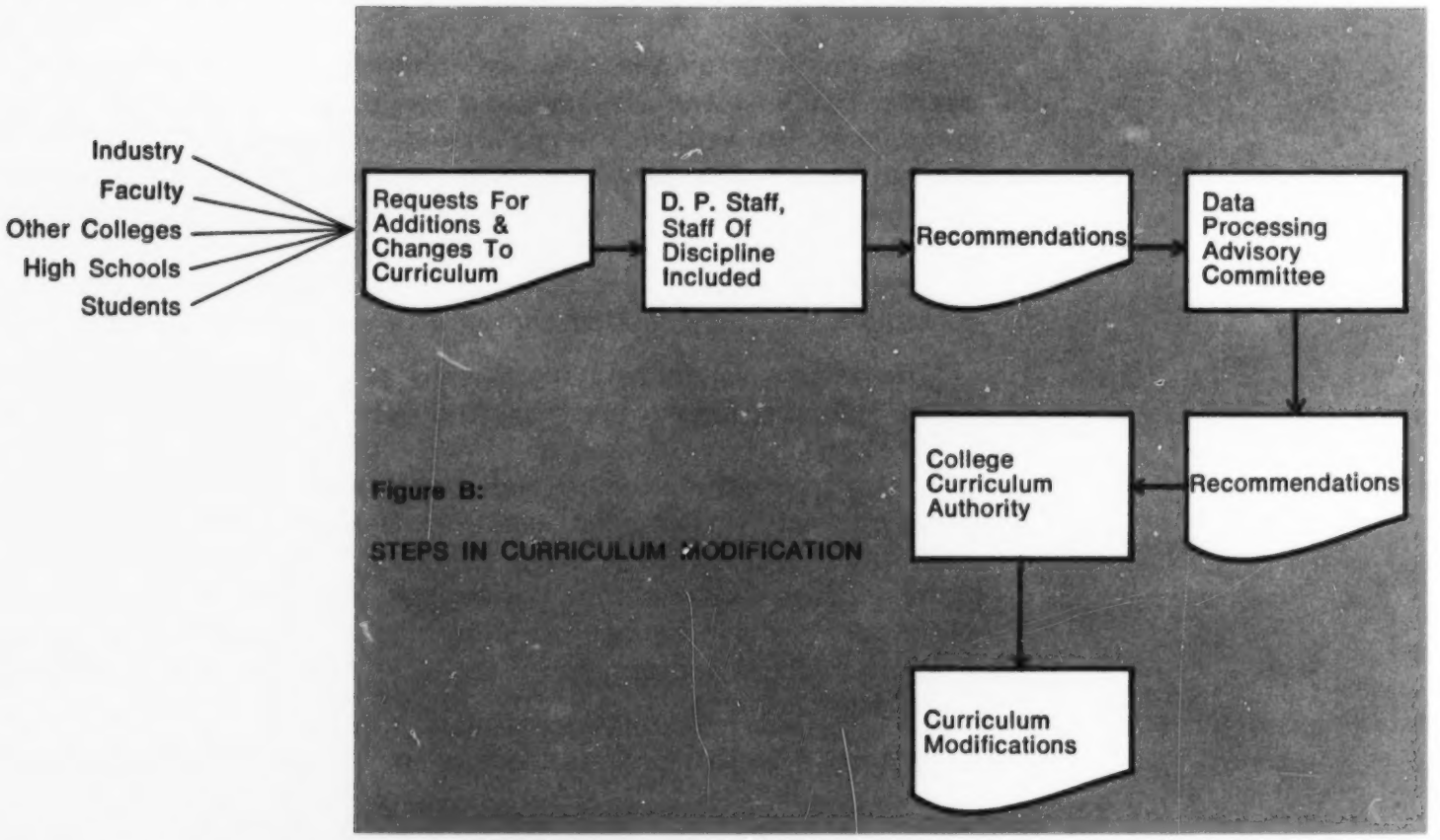


Figure B:

STEPS IN CURRICULUM MODIFICATION

V. Staffing

A versatile, technically competent staff is absolutely essential to a sound junior college program in data processing and computer programming.

An important component of any educational program is a competent, well-qualified staff. This is especially true in data processing programs. Some problems relevant to the staffing of an instructional program were discussed in *The Computer and the Junior College.*[4] The purpose of this section is to discuss staff training and other related problems.

Staff Requirements

The problem of staff training needs to be placed in proper perspective. Staff members should meet certain basic qualifications, namely professional training and occupational work experience. Professional training will usually be translated into degree requirements as dictated by local institutional policy. Local policy is obviously influenced by state certification agencies and accrediting associations; it may also be influenced by decisions made through meetings with local universities and four-year colleges. Occupational work experience is normally stated in terms of months of work experience in industry directly or in a related occupation for which training is offered. Full or provisional certification or approval is normally a function of a state educational agency such as a division of the state board for vocational education.

It is next to impossible to employ an individual under 30 with a master's degree, three years of teaching experience, and three years of work experience at the same salary received by staff members of other academic disciplines having similar credentials. The staffing problem is complicated by a number of factors.

1. Universities generally are not preparing individuals for teaching in data processing programs. Therefore, they do not represent a very likely source for these teachers. Neither should an administrator expect to find an abundance of staff who have had professional training, such as a major in data processing, or a degree in this field.

2. A sizeable number of teachers in data processing programs have come to educational institutions from industry. Many of these teachers have both degrees and strong technical backgrounds but few have developed expertise in teaching. The college that staffs a program with individuals offering this type of background must be prepared to assist these teachers to develop an understanding of the teaching-learning process, testing and measurement, use of instructional media, and other matters of professional education.

[4] *Ibid.*, p. 12.

3. Data processing teachers should have a singular responsibility for teaching, as suggested earlier. Too often data processing teachers have been given dual responsibility for teaching and handling the administrative data processing—two full-time loads. Under these conditions, it is impossible for the teacher to perform effectively at either job. There is no such thing as a part-time job in either data processing or in education.

4. Data processing teachers must be paid salaries commensurate with those offered in industry, which may create problems for the administrator. These salaries are normally higher than those paid to staff members of comparable skill and experience in other disciplines. The data processing teacher should have the technical expertise required by industry and therefore find an easy lateral mobility back to industrial positions. Because there is a shortage of these teachers throughout the country, opportunity to move to other institutions is frequent. Moreover, because of their backgrounds, these teachers can easily move into administrative positions.

5. Data processing teachers need frequently to update their knowledge, understanding, and skills. Computer technology is dynamic. All evidence regarding present and predicted technological change indicates updating problems will remain acute.

6. College administrators of data processing programs should be aware of the problems created when there are substantial staff turnovers. In many cases there are only one or two teachers on the staff who have the qualifications to teach highly specialized courses. A high staff turnover can have disastrous effects upon the quality and continuity of the program.

7. Good data processing programs are viable. As technology changes and as employer needs change, programs need to adjust. This means the teaching staff will be continually updating their knowledge and skills, searching for adequate instructional and learning materials, revising the curriculum, and actively participating in advisory committee work.

To summarize, one can see that the data processing teacher: is not being prepared on any appreciable scale in the universities; is located in industry and lured into education; may require a salary above the average of that paid to other teachers; should devote his time exclusively to the teaching-learning process; is in constant need of updating technical skills and knowledges; may be difficult to retain on the staff; and is heavily engaged in activities that lead to program relevancy.

For the administrator wishing to initiate a data processing program, staffing may be more difficult than acquiring a computer system. What can be done, and what kinds of training are available?

Staff training can be thought of as taking place in two phases: preservice, and in-service education. The former includes courses taken and experience acquired prior to teaching in the data processing program. In-service training is that received by the experienced teacher for the purpose of updating and upgrading.

Preservice Education

Several universities and other four-year colleges have begun offering courses related to computers. The growth in offerings and in the number of universities making the offering can be expected to increase. Generally, these courses are offered in a science-oriented discipline such as mathematics, statistics, and engineering, or in a business-oriented field such as business administration or accounting. In a few universities, both options are available. Although many universities are offering courses at both the

undergraduate and graduate levels, few are providing in-depth study. In those that are, it is usually found in a computer science program. This is not the most appropriate type of training for the junior college data processing teacher. There are virtually no specially designed curricula in the universities for the preparation of the junior college data processing teacher.

A study of university offerings—including an analysis of data processing courses, correspondence, and discussion with responsible university personnel—will assist the administrator in evaluating preservice education obtainable in those institutions from which his faculty may be drawn.

Attempts at pre-service education have been made which are of a different nature. Between 1963 and 1965, under a project funded partially by federal money, 347 teachers received summer institute training in data processing. When funding for this project ceased, several states initiated training programs in an attempt to alleviate the teacher shortage. In 1969, forty-five teachers were trained in summer institutes at Western Illinois University and Orange Coast College under funding from the Education Professions Development Act (EPDA).

Specially designed summer institutes and workshops such as those described above have been a help in staffing many data processing programs. Recognition must be given, however, to the fact that summer institutes cannot possibly provide the data processing teacher with all the skills and knowledge needed. The training received, although intensive and in-depth, is but a start and requires of the teacher a program of continued self-study.

Computer equipment manufacturers generally have a rather extensive offering of educational courses. Such courses are highly technical, usually of short duration, and are designed primarily for users of the manufacturer's equipment. In the past, these courses were tuition free; today, however, some manufacturers expect participants to pay.

Preservice education would also include the training received by teachers who embark upon a self-study program and those who return to the university during summers and enroll in computer-related courses. It would also include the training received by the potential data processing teacher who enrolls in adult education or extension courses offered by other community colleges.

In-Service Education

Sources for in-service training are also in short supply. A few of the summer institutes which are available from time to time have a component which is designed especially for the experienced teacher. More advanced training in the technical specialty courses, in addition to training on newer generations of equipment, are strong features of these programs. The sharing of common problems and seeking of common solutions to problems regarding an entire instructional program are also strong features of such a program and should not be overlooked.

For the experienced teacher, in-service training is most readily available from computer equipment manufacturers. The administrator must recognize inherent problems such as released time for the staff member to attend, and expenses related to travel, *per diem,* and tuition. This type of training is justified in that the teacher enrolls only in those courses in which he has an immediate need; the training is highly specialized, and is normally three weeks or less in duration.

Other in-service training opportunities are available through professional workshops, seminars, and meetings. These may be conducted by a consortium of community colleges, professional associations, or technical societies. Invited guest speakers such as data processing manufacturers or employees of local installations, may be brought in for a meeting, or a series of meetings, to help the staff increase its effectiveness. Staff members may also increase their competence and knowledge of the field and current practices by making site visits to local computer installations.

Part-Time Staffing

In addition to the program's full-time faculty, the junior college should consider employing, on a part-time basis, people who work in data processing in the area served by the college. There are a number of avenues open.

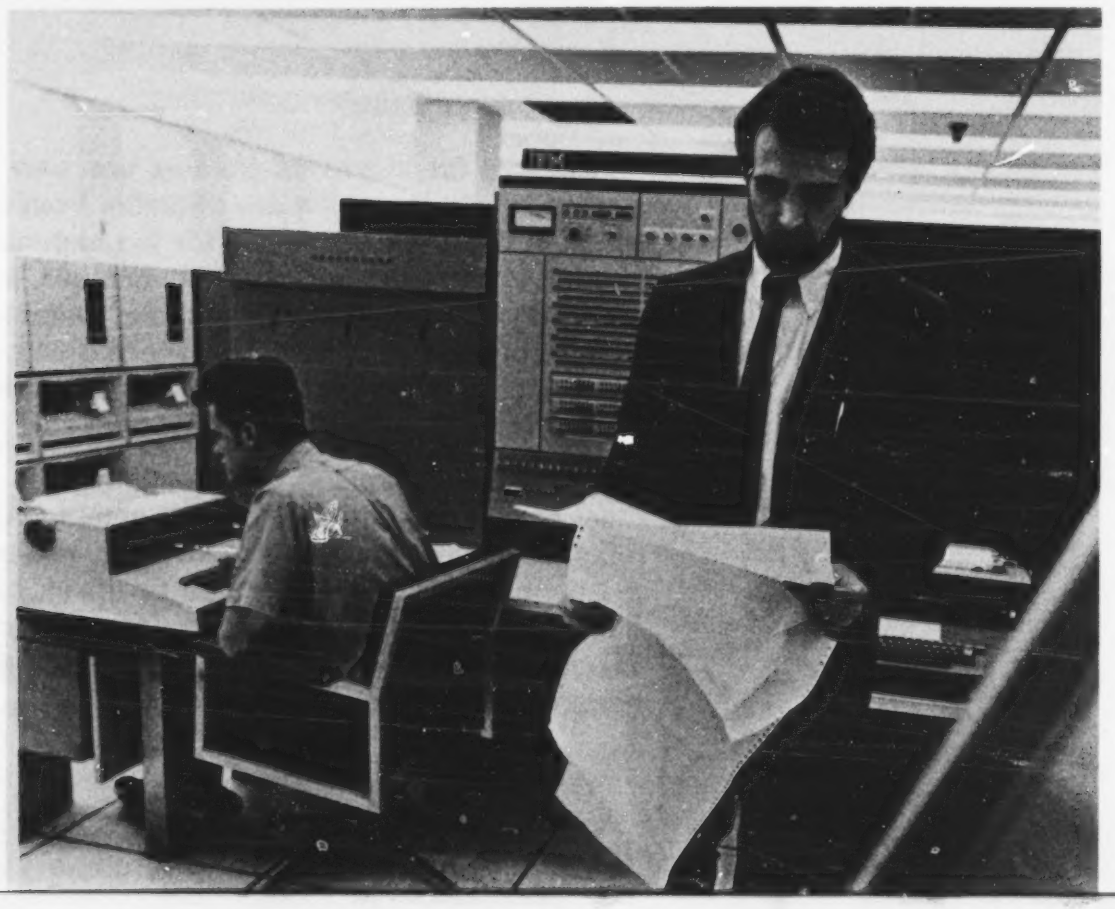
Cooperatives allow instructors in the data processing area to change positions with someone in industry for a semester or a year. The instructor would gain the experience necessary to become more effective in the classroom and the school would benefit by having an experienced practitioner available to the students.

In staffing for specialized or evening courses, many practitioners in the field are willing to offer their services on a part-time basis.

Many men and women are willing and eager to teach during their retirement and many have been associated with data processing for the major portion of their career.

If the college has a staff to perform administrative data processing functions, it may consider using this staff on a part-time basis for teaching courses in the data processing curriculum. Many colleges do this. There remains, however, the same objection to this procedure as is found with assigning responsibilities for both the administrative and the educational data processing program to one data processing director—the individual's loyalties are divided and their effectiveness decreased.

For many institutions, these suggestions for staffing will involve changes in current hiring practices and related salary adjustments. If this is what it takes to get a competent staff, colleges must be prepared.



VI. Communication

Establish firm communication with local high schools training students in the field.

Junior college programs are designed to prepare graduates to seek entry-level jobs solely on the basis of their junior college education. These programs form a most significant part of the comprehensive junior college program. However, it often happens that students complete an occupational program and want to continue their formal college education to earn a bachelor's or an advanced degree. Students entering the junior college data processing program may come from high schools that offered training in the field; these students should expect to be given recognition for work they have completed and for skills they have already developed. This section will highlight some considerations surrounding articulation of the data processing program with local high schools and other colleges.

From High School

When beginning a program in data processing, pay close attention to local high schools that train students in the field. Some of their introductory courses satisfy the requirements of beginning courses in the college. It is important to establish firm communication between the high schools and the junior college. Some ways of doing this are described below. As suggested, articulation efforts serve best those specialized courses that go beyond the introductory level courses, although the techniques may be used for all types of data processing instruction.

1. Send data processing instructors to the high school to provide instruction to students in specialized areas.
2. Bring high school students to the college for specialized instruction. The advantages here are obvious. The junior college can expand its curriculum at the upper end while the high school student can investigate this dynamic field prior to college entrance.
3. Update the high school instructor in a specialized area to be offered to students there.
4. Establish and publicize guidelines for exempting or giving credit to high school graduates who subsequently enroll in the junior college program.
5. Utilize qualified high school faculty in continuing education courses.
6. Share computer facilities with local industry or other educational institutions when satisfactory financial and scheduling arrangements can be made.

To Four-Year College

Transferring credits from a junior college to a four-year college or university has been a long-standing problem. The evaluation and acceptance or rejection of credits earned at other institutions has traditionally been the responsibility of the institution to which they are transferred. This is as it should be.

A few states, and many colleges and universities, are attempting to solve transfer problems. Numerous articulation conferences are held annually. Dialog between data processing teachers at both types of institution generally results in arrangements that ease the problem. It is important that these conferences continue and expand.

Students who complete one of the occupationally oriented curricula given in Chapter III of this booklet, and who subsequently decide to obtain a bachelor's degree, must realize that in many cases the technical background developed at the junior college will have to lie dormant until degree requirements are completed. Once a student decides to obtain a bachelor's degree, he should assume responsibility for inquiring into problems of transfer. If this decision is postponed until near completion of the data processing occupational program requirements, he should realize that not all credits earned, and in some cases only a few, will be accepted by most four-year colleges. The question of whether they *should* be accepted is one that has enlivened many conferences; it may have to be settled ultimately by policy emanating from governing boards, or by state-legislative enactments.

Development of job-entry skills for a programmer trainee or a computer operator is a worthwhile goal of junior college data processing programs; the goals of the university information science programs, where developed, are more nearly fitted to the knowledges and understandings needed by the computer installation manager, systems programmers, systems analysts, programmer supervisors, and procedure or methods analysts. The technical skills, knowledge, and understanding developed in the junior college data processing program are an important and necessary part of each of the occupational choices shown above. It would seem therefore, that a rationale and statements of justification could be developed in obtaining university acceptance of credits earned in these programs. When a student changes his objectives—whether laterally, such as to a different major, or vertically, such as a change within the same major—he should expect some loss of credits but he should not be penalized unreasonably.

The articulation problem—though difficult, time-consuming, and complex—can be solved. Many four-year colleges which offer courses in business-oriented information science have begun to accept transfer credit for introductory courses and beginning programming courses. There is good reason to hope that as more four-year colleges and universities develop these programs, a liberalization of transfer credit will be made. College teachers and administrators can and should play an important role through conferences, site visits, and state-wide professional meetings.

VII. Evaluation

Good data processing programs are viable.

Frequent mention has been made of the need for continued redesign of the data processing program to assure that it continues to meet current needs of the community and students. Such redesign, of course, is predicated upon evaluation.

The purpose of evaluating a data processing program is to assess achievements and to make improvements. The process of evaluation should be continuous and should include analysis of relevant data gathered from a variety of pertinent reference groups. Evaluation should, therefore, be both descriptive and judgmental. This section covers methods and techniques helpful to evaluation.

Surveys

There are many types of surveys. Data can be gathered from interviewing and from mailed questionnaires.

A survey of employers who hire people for their computer centers often reveals useful information, for example, on entry requirements, employment standards, promotional opportunity, and earnings. Employers who have hired program enrollees (both graduates and non-graduates) should be able to make valid judgments of their preparation and formal training while in school.

An equipment survey may facilitate course revisions, hardware replacement, and expectations for students. Source material covering survey administration and techniques is available from the American Association of Junior Colleges.

Cooperative Education Programs

The broad category of cooperative programs includes two basic types. First, the traditional part-time work experience programs in which the student spends a portion of the day in school and a portion of the day working in an approved training or work station. Second, the internship program, in which a student spends a quarter or a semester working full time for an employer in an approved, directly related occupation and spends alternate periods in full-time college study. Either type of program facilitates evaluation, although part-time employment seems more popular with students.

The individual assigned to coordinate a cooperative program has several opportunities to gather data for evaluation. For example, useful information might be obtained when locating, inspecting, and approving employment stations developing a training plan, and while selecting and placing students. As the cooperative program becomes operational, additional information can be collected when supervisory visits are made. At each stage in the development and operation of this kind of activity, objectives should be reviewed, and modified where necessary.

At the close of the work experience period, teachers, students, and employers should be expected to evaluate their experiences, and the program in general. These evaluations will provide information which will help to identify strengths and weaknesses and to point out needed revisions.

Follow-Up

A follow-up study is another of the many evaluative tools that may be used. For example, it could be designed to gather data relative to those who were employed in directly-related, related, or unrelated occupations; those who are attaining success or failure; and elicit opinions relative to needed program revisions, such as courses, course content, requirements and electives, texts, equipment, or staff, and salary data. The follow-up study should include former program enrollees; more meaningful data can be gathered from this group than from program graduates only. Data gathered only from program graduates fails to take into account students whose studies were terminated before completion.

Even more meaningful than a follow-up study would be a follow-up program. The follow-up program may be designed as a continuous procedure in which enrollees are followed up after six months or longer following an academic year, and program graduates are followed up twice more on an annual basis.

Advisory Committee

Members of the advisory committee for the data processing program can make valid judgments about quality and appropriateness of the program. As the purpose of the advisory committee is to give advice, it can render valuable assistance in such areas as curriculum, course content, staffing, teaching, and learning materials, invited guest lecturers, installation visits, and training or work stations for cooperative students. Members of the advisory committee could be asked to evaluate the program on a formal or informal basis.

Evaluation is necessary if programs are to be relevant. Evaluation then, should be considered a continuous process of collecting information from all pertinent reference groups (students, employers, advisory committee members, teachers, and administrators) for the purpose of making judgments about the effectiveness of a curriculum. Program results should be compared to program objectives. These results should also be compared to standards and to other comparable programs. Once this has been accomplished, strengths and weaknesses will be identifiable and decision-making for program improvement more easily accomplished.

VIII. Getting Started

There is no such thing as a part-time job either in data processing or in education.

Throughout this booklet, repeated references have been made to things that should be done to implement and operate a junior college program in data processing and computer programming. This concluding part reviews some of the material previously presented and outlines the order in which certain events should take place during the gestation period and birth of the new program.

Establish Objectives

The primary objectives of a junior college program should be the preparation of graduates able to fill entry-level positions as computer operators and business applications programmers. An additional objective calls for providing opportunities for continued study by individuals already employed in data processing. As the first step in the process of establishing a data processing program, the objectives must necessarily be rather broad in nature. Refining the goals and expressing them in terms of specific skills and abilities to be learned by students must await input from community surveys and advisory committees.

Survey the Community

There are a number of methods of surveying the community that are available. Probably the easiest, but not necessarily the best in terms of quality of information gained, is mailing questionnaires to area firms. Questionnaires can be used to learn about the types of data processing equipment in the area, shortages of particular kinds of data processing personnel, plans for future data processing requirements and activities, and a general feeling for whether or not the firms responding are amenable to the notion of hiring two-year college graduates as programmers.

Personal interviews with local data processing professionals as well as with personnel managers are also a useful source of information about local industry needs and how the junior college is seen by these individuals as a means to meet them. Interviews are potentially informative, and offer an opportunity for pre-selling the college program and its graduates.

Contacts with local chapters of the Data Processing Management Association, the Association for Computing Machinery, other trade associations, representatives of computer equipment manufacturers, and chambers of commerce will also serve as important sources of information in surveying the community. Similarly, interviews with local high schools, four-year colleges, and with state and local employment services should provide important information to be used in planning the curriculum. Such organizations may also prove to be sources of students for the program, or at least an important means by which the program can be publicized.

Form an Advisory Committee

The advisory committee will serve as a continuing source of information, as well as an important link with the community and a means of updating the program. The advisory committee should be formed early in the planning so its members come to look upon it as their own. Membership should include representatives from data processing installations in the area, preferably those who are hiring or will hire students as part of the co-operative education program.

Determine Organizational Structure

Once the objectives are determined in some detail, the college will be in a position to select the manner in which data processing will fit into the organization of programs. The alternatives include: establishing a separate data processing department or division of instruction; or establishing a smaller instructional unit as part of the established business or mathematics division. In either case, data processing instruction should cut across several disciplines.

Hire or Appoint Staff

Staffing problems associated with junior college programs in data processing have already been discussed. All that needs to be added at this point is that the staff responsibilities should be assigned *after* the specified objectives of the program are formulated. Objectives should not be designed to match the teaching abilities of available staff—they should be established *before* the curriculum is written. The teaching faculty should play an active role in developing the coursework.

Design Curriculum

Curriculum design along the lines described in this booklet can be facilitated by perusal of course outlines and specific curriculum matters obtained from other junior college data processing programs. Whether or not this is done, it is most important that the curriculum, and each of the courses and other learning experiences making up the curriculum, are designed to meet the specific objectives of the program.

Formulating means by which the curriculum is evaluated in terms of meeting its objectives is part and parcel of designing the curriculum. Evaluation systems involve follow-up activities, work with advisory committees and employers of students in cooperative education programs, and surveys of current data processing trade literature.

Determine Equipment Needs and Sources

Needs of the data processing educational program for specific kinds of computers and other data processing equipment can only be determined after the curriculum has been completely designed. It cannot be overstated: beware of the widespread practice of *first* getting a computer system and then wondering what to do with it.

A small beginning in terms of size of computer installations is advisable. All of the needs, in terms of language support and operating system characteristics, required for all but the most elaborate junior college data processing programs can be met with fairly small computers leasing for less than $5,000 per month. Some very small systems can serve a limited program at monthly lease costs of about $2,000. Upward compatibility for modern computer systems is quite good. This means that it is relatively easy to adapt computer programs and other educational processes to larger computers once it is established that the small computer first installed is no longer large enough to do the job.

Make Equipment Available

Making the necessary equipment available is a matter of taking action on one of the alternatives discussed in Chapter III. Delivery times for computer equipment from most major manufacturers range from a couple of months to over a year, depending upon the system being ordered and the manufacturer supplying it. This time lag should be taken into account when planning for the first course offerings of the curriculum.

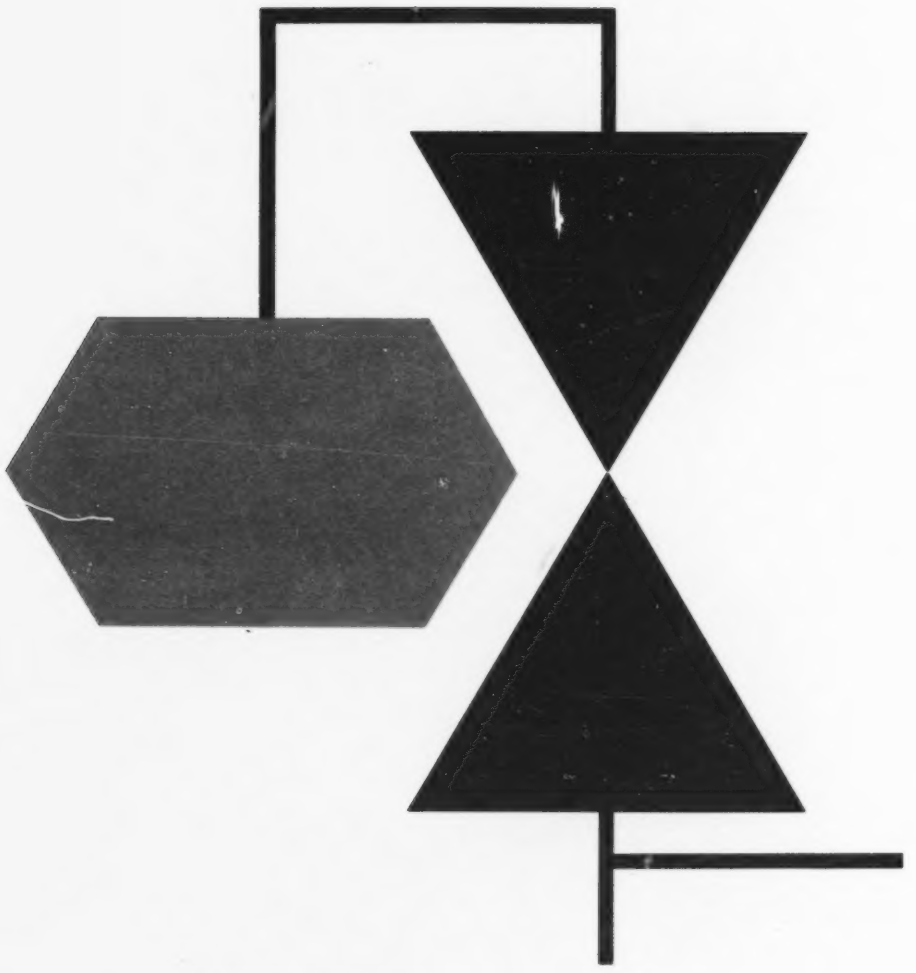
If the college already has a data processing installation, matters pertaining to equipment selection may be out of the control of curriculum planners. In our view, the priority use of a junior college computer installation should be for the data processing educational program, if there is one. Acting upon this priority, the computer system should be modified or replaced with one which will serve both the needs of administrative data processing and the educational program, if the one installed does not already do so.

One other feature deserves mention at this point. Many two-year and four-year post-secondary institutions feel tempted to install larger computers or multiple computers when faced with conflicting time demands from the educational program and administrative users. To the extent that the computer system stands idle at night or during the weekends (usually a sizable extent, we have observed), there is little justifiable reason to enlarge the computer system. In such a situation, one would expect routine administrative tasks to be executed at night or on the weekends when students typically do not require the computer system. This seems more desirable to us than installing a large computer system which is heavily used 40 hours or so per week and stands idle the remaining 136 hours.

Begin the Program

The courses are designed, the equipment is available, and the faculty is ready to begin. All that remains is to enroll students in the program. This can be done with considerable fanfare, however, netting the college some publicity. Computers and the use of computers remain newsworthy items and the college will probably not want to miss a good opportunity to let its public know about the new program that it is offering.

We have dealt at length with evaluation and modification procedures for the data processing educational program. These can be started soon after the first classes begin instruction through the expedient of conferring with the teaching faculty and the students to determine how well the course work and the instruction is being received by students. After the first semester or quarter is over, more formalized follow-up procedures and other evaluation techniques may be implemented.



Appendix I

Appendix II

WHERE TO GO FOR HELP

Association for Computing Machinery
1133 Avenue of the Americas
New York, New York 10036

Association for Educational Data Systems
1201 16th Street, N.W.
Washington, D.C. 20036

Association for Systems Management
24587 Bagley Road
Cleveland, Ohio 44138

Data Processing Management Association
505 Busse Highway
Parkridge, Illinois 60068

The Institute of Electrical and Electronic Engineers, Incorporated
345 East 47th Street
New York, New York 10017

The Society for Management Information Systems
1 First National Plaza
Chicago, Illinois 60670

American Federation of Information Processing Societies
210 Summit Avenue
Montvale, New Jersey 07645

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AMERICAN ASSOCIATION OF JUNIOR COLLEGES
One Dupont Circle, N.W.
Washington, D.C. 20036